Revere Beach, Massachusetts
Final Report

Beach Erosion Control

JUNE 1981

US Army Corps of Engineers
New England Division

REVERE BEACH
MASSACHUSETTS

BEACH EROSION CONTROL

FINAL REPORT

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

JUNE 1981

BEACH EROSION CONTROL
REVERE BEACH, MASSACHUSETTS
FINAL REPORT

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A. INTRODUCTION

1. General. This report is intended to bring together all the information obtained during the course of the New England Division's efforts relative to the erosion control project at Revere Beach in Revere, Massachusetts. The technical information relating to the existing beach and recommendations concerning beach fill material in the Geotechnical Appendix will be useful to anyone considering reconstruction at Revere Beach.

2. Purpose. The purpose of this report is to present the results of an objective reassessment of the Beach Erosion Control Project. It also presents data, in sufficient detail, to justify the findings and recommendatiions contained in the report.

3. Scope. This report presents data on the project need, estimated costs and estimated benefits.

B. PROJECT AUTHORIZATION

4. Authorization. The Revere Beach Erosion Control Project was authorized under provision of Section 201, Flood Control Act of 1965 (P.L. 89-298) and approved by House Public Works Committee Resolution dated 1 December 1970 and Senate Public Works Committee Resolution dated 17 December 1970. The pre-authorization report is published as House Document No. 91-211, 91st Congress, 2nd Session.

5. Previous Projects and Reports. A previous Federal project at Revere Beach was partially constructed in 1954 by the Metropolitan District Commission, the local cooperating agency. Construction was discontinued prior to completion of the project because the sand fill, obtained from an offshore borrow site by dredging, was too fine to stay on the beach. Additionally, a Beach Erosion Control Report was completed by the New England Division, Corps of Engineers in March, 1968. That report formed the basis for the currently authorized project.

C. DESCRIPTION OF AUTHORIZED PLAN

6. Description. The authroized project provides for beach widening by direct placement of suitable sandfill along 13,000 feet of beach fronting the Metropolitan District Commission Reservation to a general backshore elevation of 18 feet above mean low water, furnishing a recreational and protective beach averaging 185 feet in width behind the mean high water line. (See Plates 1 & 2)

D. CURRENT NEEDS AND EVALUATION

7. Needs and Evaluation. The need for a beach erosion control project must be based on evidence which indicates that the beach is, in fact, eroding. Two measures of evaluating erosion of the shoreline are the dry beach area and the volume of the material on the beach.

The dry beach area for Revere beach is the area between the mean high water line and the seaward face of the concrete walls and aprons. Areas of protective stone are not included in this dry beach area. Table 1 is a history of the dry beach area as determined by Corps of Engineers' surveys for the period 1945 to 1980. The 1980 survey is shown on Plates 1 and 2. This table shows that the dry beach area has been increasing during this period. Based on dry beach area, there is no pattern of erosion of the shoreline and, therefore, no need for a beach erosion control project.

The second measure of evaluating the beach in terms of erosion is the volume of material on the beach. The volume of material for Revere Beach was defined as the material bounded by the plane of mean low water, the plane of the seaward face of the concrete walls or aprons, and the surface slope of the beach itself, as shown on Plates 3, 4 and 5.

Table 2 is a history of the beach volume for the period 1945 to 1980. Evaluation of this data is inconclusive as to whether the beach volume is increasing or decreasing. Instead, Table 2 shows the normal dynamic nature of a beach, that is, alternating movement of material on and off the beach. Based on volumetric beach changes, there is no consistent pattern of erosion and, therefore, no need for a beach erosion control project.

Therefore, based on the two best measures of evaluating beach erosion, there is no need for a beach erosion control project at Revere Beach.

TABLE 1

DRY BEACH HISTORY

YEAR	DRY BEACH AREA (S.F.)
1945/46	915,000
1962	1,310,000
1980	1,340,000

TABLE 2

VOLUMETRIC HISTORY

YEAR	BEACH VOLUME (C.Y.)
1945/46	1,330,000
1962	2,175,000 *
1980	1,470,000

*Includes 175,000 c.y. nourishment in 1954

E. GEOLOGY AND SOILS

8. Geology. Revere Beach is located within the Seaboard Lowland section fo the New England physiographic province. The area is characterized by relatively flat and gently sloping terrain with some hilly sections. Elevations range from tide level at the shoreline to over 175 feet NGVD (National Geodetic Vertical Datum). Low lying areas are dominated by recent marsh sediments, primarily peat and organic silt. Coastal areas are covered by sand with some gravel. Artificial fill is present in various locations. The principal bedrock type in the area is the Cambridge Slate, which is also known as Cambridge Argillite. Igneous intrusions and volcanics are also found in the region. Details are contained in Appendix B.

9. Soils. Revere Beach is reltively flat and gently sloping. The beach slope varies from 1:8, vertical to horizontal, to 1:25 above mean low water and between 1:60 and 1:100 below mean low water. The present beach material is a fine to a medium fine sand with patches of gravel and traces of silt. Median diameter (D_{50}) of the material ranges from 0.09 to 0.20 mm and averages approximately 0.15 mm. Maximum diameters (D_{100}) are quite variable, ranging from 0.50 mm to over 7.0 mm. The median diameter of the sand fill should be approximately 0.30 mm and the maximum size particle should be 2.0 mm in diameter. Investigations, consisting of field reconnaissance trips, sampling, testing of materials, and discussions with commercial representatives, were conducted to delineate potential sources of sand fill. Efforts were concentrated on commercial land sources and on off-shore sites. Eight commercial sources were investigated. Of these, five can provide the full quantity (approximately 1,000,000 c.y.) of material needed. The sources can meet the size criteria with selective pit operation or dry screening at the site. Five potential off-shore sources were also investigated. One of these sites, near Cat Island off Salem, Massachusetts, was investigated in detail. Results from the explorations revealed that sufficient quantities of suitable material are not available from off-shore sources. Details are contained in Appendix B.

F. COST ESTIMATES

10. First Costs. Unit prices used in estimating construction costs are based on obtaining the material from a land-based commercial borrow pit at 1 April 1981 price levels. The quantity estimate is based on a topographic survey made in 1980 and includes two years (estimated) annual nourishment.

Construction costs include an allowance of 20% contingencies for the beach replenishment. Costs of engineering and design, and of supervision and administration are based on experience, knowledge and evaluation of the site, and the proposed work to be accomplished. The total first cost is estimated at $8,900,000. A summary of current costs for the project features is given in Table 3.

TABLE 3

SUMMARY OF COSTS
(1 April, 1981 Price Levels)

Acct.	Feature	Estimated Costs
01.	Lands & Damages	-0-
17.	Beach Replenishment	
	Sandfill, 1,000,000 c.y. @ $6.50/cy	$6,500,000
	Contingencies	$1,300,000
	Total Beach Replenishment Cost	$7,800,000
30.	Engineering and Design	$505,000
31.	Supervision and Administration	$585,000
50.	Construction Facilities	$ 10,000
	Total Estimated First Cost	$8,900,000

11. Annual Charges. Average annual charges, summarized below in Table 4, are based on an anticipated project life of 50 years and an interest rate of 7-3/8%. Annual maintenance costs are based on beach replenishment of 4,000 c.y. per year to reshape the beach after the winter storm season.

TABLE 4

ANNUAL CHARGES

Interest and Amortization (.075913 x 8,900,000)	$675,000
Maintenance 4,000 cy @ $6.50	26,000
Total Annual Charges	$701,000

G. ESTIMATE OF BENEFITS

12. General. The benefit analysis is based on a 50-year project life at a 7-3/8% interest rate. There are two distinct types of benefits which would result from construction of this project, recreation and direct (flooding) damages prevented. Appendix A contains a detailed analysis as to how these benefits were determined. The following two paragraphs explain the process in general terms. Annual estimated benefits are shown in Table 5.

13. Recreation Benefits. Recreation benefits are based on the increased number of visitors, above the existing capacity of the beach, who are expected to use the beach after it is improved. A value of $2.00 per summer visitor and a beach useage turnover factor of two are assumed.

These assumptions appear reasonable based on the location of the beach and useage factors of other beaches in the general area. Only weekend days are used in this calculation because the existing beach is large enough to accommodate the expected number of weekday visitors. Annual recreation benefits are estimated at $39,000.

14. Benefits from Direct Damages Prevented. In addition to increasing the area available for recreation, construction of a 185' wide beach berm would also cause waves to break on the beach away from the concrete seawalls. This would decrease the amount of wave damage to the seawalls and prevent flooding of the backshore area behind the seawalls. Annual benefits from direct damages prevented are estimated at $25,000.

TABLE 5

SUMMARY OF ANNUAL BENEFITS

Description	Amount
Recreation	$39,000
Direct Damages Prevented	25,000
Total Annual Benefits	$64,000

H. BENEFIT TO COST RATIO

15. Benefit to Cost Ratio. Comparison of the annual benefits of $64,000 and the annual charges of $701,000 results in a benefit-cost ratio of 0.1 (0.09) to 1.

I. STATEMENT OF FINDINGS

16. General. All pertinent data concerning the proposed construction of the Federal beach erosion control project at Revere, Massachusetts have been reviewed and evaluated. Elements considered in this review and evaluation included engineering feasiblity, project justification, and the socio-economic factors relative to its construction.

No definitive evidence of an erosion problem at Revere Beach was found. In addition, the benefits from recreation and flooding damages prevented, are insufficient to justify Federal participation in a beach erosion control project at Revere Beach.

J. RECOMMENDATIONS

17. Recommendations. The authorized project for Revere Beach is neither required nor justified at this time. Therefore, it is recommended that the Revere Beach Erosion Control Project in Revere, Massachusetts be placed in an inactive status.

CORPS OF ENGINEERS

U. S. ARMY

N514000

N516000

N518000

N510000

N512000

E738000

E740000

E742000

REVERE BEACH

REVERE BEACH PARKWAY

WINTHROP PKWY.

EL. 10

CIRCLE

R-16

R-14

R-12

R-10

R-8

R-6

R-4

R-3B

R-3A

SHIRLEY AVE.

BEACH ST.

CHESTER AVE.

REVERE BEACH BLVD.

OAK ISLAND ST.

CONC. APRON

EXISTING M.H.W. EL. +9.0'

PROPOSED M.H.W. EL. +9.0'

PROJECT LIMITS

SOUTHERN LIMIT OF BEACH FILL

MATCH LINE PLATE 2

ROUGHANS POINT

REVERE BEACH

BROAD SOUND

TYPICAL PROFILE
BEACH FILL
SCALE:
HOR. 1"=100'
VERT. 1"=5'

50'
135'
El. 18.0
15
1
Existing Bottom
El. 9.0 (M.H.W.)
Proposed Sand Fill
40
1

LOCATION MAP
SCALE 1"=37.5 MILES

CANADA
MAINE
BANGOR
AUGUSTA
NEW HAMPSHIRE
PORTLAND
CONCORD
PORTSMOUTH
VT.
BOSTON
REVERE BEACH
MASSACHUSETTS
HARTFORD
PROV.
CONN
R.I.
ATLANTIC OCEAN

GRAPHIC SCALES
1:5000
200' 0 200' 400' 600'
1"=37.5 MILES
37.5 MI. 0 37.5 75.0
1"=100'
100' 0 100' 200'
1"=5'
5' 0 5' 10'

Profiles based on April, 1980 surveys.

Datum is Mean Low Water.

LEGEND
CONCRETE STRUCTURE
STONE OR RIPRAP

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY J. O'L. | DR. BY E. J. K. | CK. BY COL

SUBMITTED: Quentin F. O'Leary, PROJECT MANAGER
REVIEWED:
CHIEF, COASTAL ENG./SURVEY SECT.
APPROVAL RECOMMENDED:
CHIEF, DESIGN BRANCH

REVERE BEACH, MA.
BEACH EROSION CONTROL
DESIGN MEMO
LOCATION MAP AND PLAN NO. 1

APPROVED DATE JUNE 1981
CHIEF, ENGINEERING DIVISION

SCALE: AS SHOWN SPEC. NO. DACW 33
DRAWING NUMBER
B.E. MASS. 62
SHEET

PLATE NO. 1

REVERE BEACH SH 1

CORPS OF ENGINEERS — U. S. ARMY

A B C D E F G H

N524000 N526000

R E V E R E

REVERE BEACH BLVD.

R-3 R-2B R-2A R-2 R-1B

EXISTING M.H.W. EL. +9.0'

PROPOSED M.H.W. EL. +9.0'

CONC. STEPPED SEA WALL

REVERE BEACH

MATCH LINE PLATE I

E740000

PROJECT LIMITS

NORTHERN CIRCLE

LYNN WAY

NORTHERN LIMIT OF BEACH FILL

POINT OF PINES

POINT OF PINES Y.C.

RICE AVE.

SAUGUS RIVER

Flood END

B R O A D S O U N D

E742000

N518000

N520000

E746000

N

MALDEN

EVERETT

REVERE

CHELSEA

ROUGHANS PT.

STATE ROUTE 107

PT. OF PINES

NAHANT BAY

NAHANT

REVERE BEACH LIMITS

REVERE BEACH

BROAD SOUND

CHARLESTOWN

WINTHROP

LOGAN AIRPORT

BOSTON

S. BOSTON

PRESIDENT ROADS

NANTASKET ROADS

PT. ALLERTON

DORCHESTER

QUINCY BAY

HULL

HINGHAM BAY

VICINITY MAP

SCALE: 1:80,000

Profiles based on April, 1980 surveys.

NOTE: FOR LEGEND SEE PLATE 1.

GRAPHIC SCALES

1:3900 200' 0 200' 400' 600'

1:80,000 8,000' 0 8,000' 16,000'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY J. O'L. | DR. BY E.J.K. | CK. BY CDF

SUBMITTED: PROJECT MANAGER

REVIEWED: CHIEF, COAST. ENG./SURVEY SECT.

APPROVAL RECOMMENDED: CHIEF, DESIGN BRANCH

APPROVED: CHIEF, ENGINEERING DIVISION DATE JUNE 1981

REVERE BEACH, MA.
BEACH EROSION CONTROL
DESIGN MEMO
VICINITY MAP AND PLAN NO. 2

SCALES AS SHOWN | SPEC. NO. DACW 33

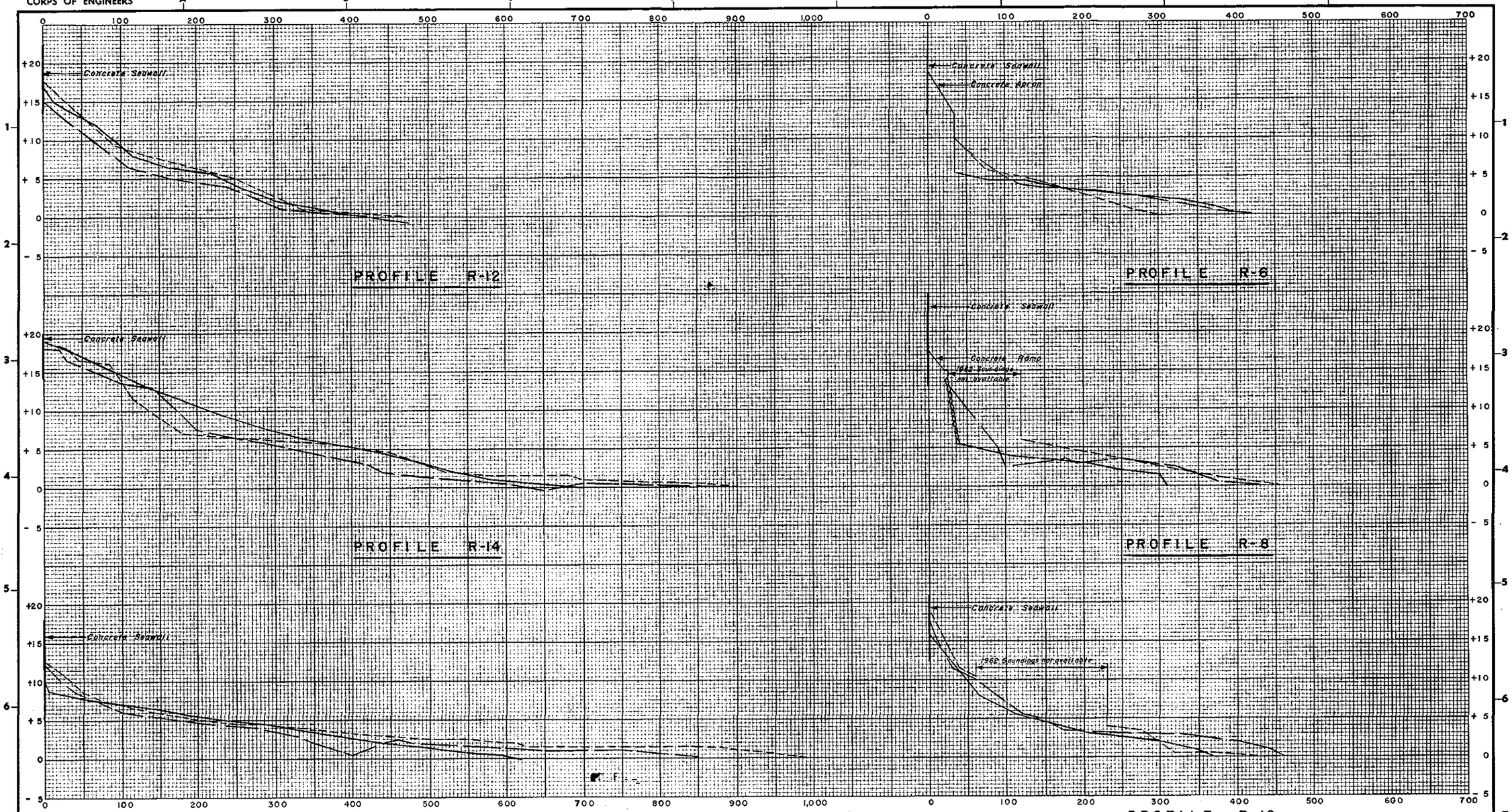
DRAWING NUMBER B.E. MASS. 62

SHEET

REVERE BEACH SH 2

PLATE NO. 2

CORPS OF ENGINEERS — U. S. ARMY



LEGEND

1980 ———————

1962 – – – – – – –

1945/46 ——— — ———

GRAPHIC SCALES

HOR. 1" = 50' 50' 0 50' 100'

VERT. 1" = 5' 5' 0 5' 10'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY J. O'L. | DR. BY E. J. K. | CK. BY

SUBMITTED: James F. Doherty, PROJECT MANAGER

REVIEWED:

CHIEF, COAST. ENG/SUR SECT.

APPROVAL RECOMMENDED:

CHIEF, DESIGN BRANCH

APPROVED

CHIEF, ENGINEERING DIVISION

DATE JUNE 1981

REVERE BEACH, MA.
BEACH EROSION CONTROL
DESIGN MEMO
COMPARATIVE PROFILES NO. 1

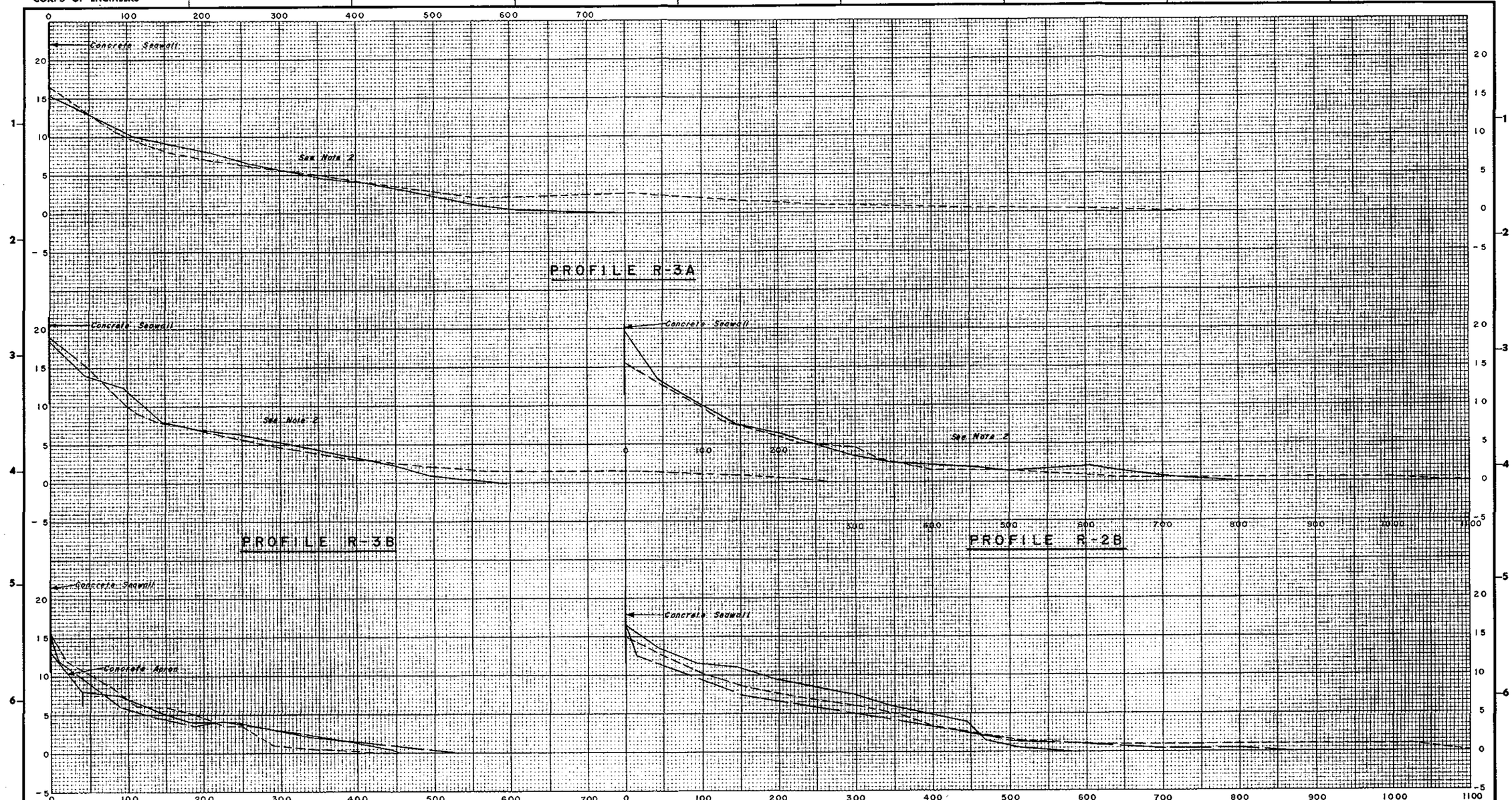
SCALE AS SHOWN | SPEC. NO. DACW 33

DRAWING NUMBER
B. E. MASS. 62

SHEET

PLATE NO. 3

CORPS OF ENGINEERS U. S. ARMY



NOTES

1. FOR LEGEND SEE PLATE 3
2. 1945/46 SOUNDINGS ARE NOT AVAILABLE.

GRAPHIC SCALES

HOR. 1" = 50' 50' 0 50' 100'

VERT. 1" = 5' 5' 0 5' 10'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY	DR. BY	CK. BY
J. O'L.	E. J. K.	

SUBMITTED: James F. O'Brien, PROJECT MANAGER
REVIEWED:
CHIEF, COAST. ENG./SUR. SECT.
APPROVAL RECOMMENDED:
CHIEF, DESIGN BRANCH

REVERE BEACH, MA.
BEACH EROSION CONTROL
DESIGN MEMO
COMPARATIVE PROFILES NO. 2

APPROVED
CHIEF, ENGINEERING DIVISION
DATE JUNE 1981

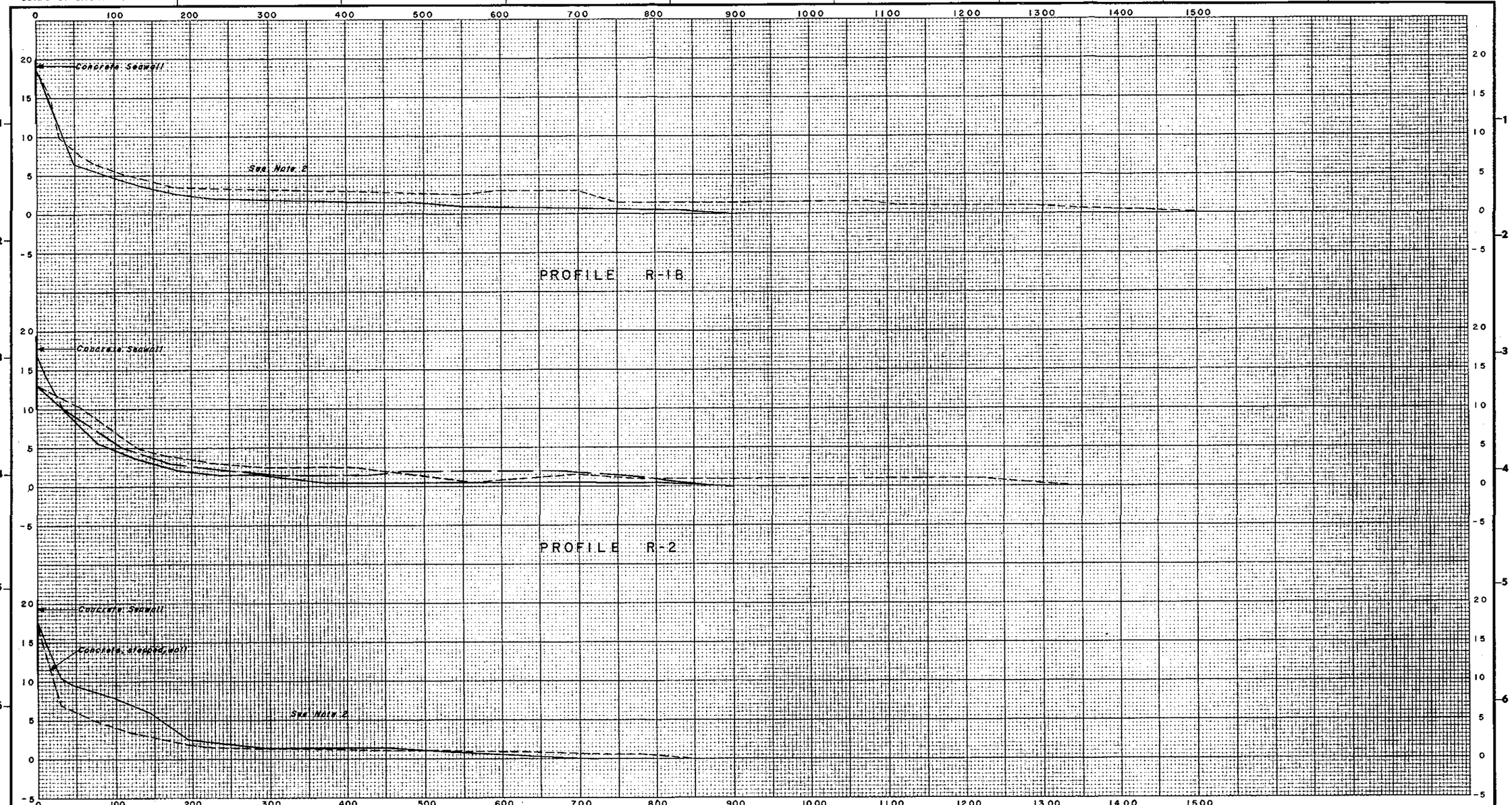
SCALE AS SHOWN | SPEC. NO. DACW 33

DRAWING NUMBER
B. E. MASS. 62

SHEET

PLATE NO. 4

CORPS OF ENGINEERS — U. S. ARMY



NOTES
1. FOR LEGEND SEE PLATE 3
2. 1945/46 SOUNDINGS ARE NOT AVAILABLE.

SAFETY PAYS

GRAPHIC SCALES
HOR. 1" = 50' 50' 0 50' 100'
VERT. 1" = 5' 5' 0 5' 10'

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY J.O'L. | DR. BY E.J.K. | CK. BY

SUBMITTED: James F. O'Leary, PROJECT MANAGER
REVIEWED: CHIEF, COAST. ENG'G/UR SECT
APPROVAL RECOMMENDED: CHIEF, DESIGN BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION

REVERE BEACH, MA.
BEACH EROSION CONTROL
DESIGN MEMO
COMPARATIVE PROFILES NO. 3

DATE JUNE 1961

SCALE AS SHOWN | SPEC. NO. DACW 33
DRAWING NUMBER: B. E. MASS. 62
SHEET

PLATE NO. 5

APPENDIX A

DETAILED ECONOMICS

APPENDIX A. DETAILED ECONOMICS

TABLE OF CONTENTS

1. Methodology

The proposed beach project for Revere Beach is analyzed for a 50 year project life at the Federal interest rate of 7-3/8 percent. The current beach usage was derived from the following three consultants' reports:

Nash-Vigier Inc. Revere Beach. Cambridge, MA. April, 1971. (for the city of Revere)

Camp, Dresser and McKee Inc. EIR: Revere Beach Development Project. Boston, MA. June 1978. (for the MDC)

Carol R. Johnson and Associates, Inc. Master Plan: Revere Beach Reservation. April, 1979. (for the MDC)

The Nash-Vigier study estimated the current beach usage using aerial photos. The photos were taken on a sunny Wednesday and Sunday in July using a turnover of two.

Camp, Dresser and McKee estimated current beach use based upon the total number of parking spaces available, beach counts, MBTA turnstile counts, and traffic figures. They based their future estimates upon MDC estimates and proposed future development in the area.

Carol R. Johnson Associates did not explain their methodology for estimating current beach use although the final attendance figures were similar to the other two consultant reports.

Nash-Vigier also conducted extensive interviews with beach users to determine the following items:

1) age, sex and number of beach users

2) origins and mode of transport

3) frequency of visits, length of visit, and time of visit

4) a comparison with other beaches

5) attitudes toward Revere Beach

The size of the beach was estimated by measuring beach profiles as discussed in Paragraph D of the main report.

2. Market Area

Fifty percent of the beach users are from Revere and adjacent communities and 87 percent of the trips to Revere Beach were less than 40 minutes. Table A-1 shows a detailed breakdown of information from the Nash-Vigier study.

TABLE A-1

Origin of Beach Users		Mode of Transport		Competing Beaches	
Area	%	Type	%	Beach	%
Revere	27	Car	46	Nahant	24
Adj.communities	21	Walk	18	Nantasket	16
Boston	12	MBTA	16	Lynn	10
Boston suburb	15	Bus	15	Cape Cod	12
Mass.	12	Other	5	Other North Shore	31
Other	13			Other South Shore	13
				Other	
Total	100	Total	100	Total	113*

The average length of stay at Revere Beach varied from 3-5 hours which supports the use of a turnover factor of two and is typical of a local beach such as Revere Beach.

3. Beach Season

The estimated beach season used in the economic analysis was 20 peak days and 50 average days. This is the figure used in the Nash-Vigier study and compares with a beach season of 20 peak days and 43 average days in the 1968 study by the Corps of Engineers.

The prime beach season is considered to be from July 4 to Labor Day and the non-prime beach season is the month of June and post Labor Day. The prime beach season is estimated to be 7 weeks and the non-prime beach season is taken as the equivalent of 4 weeks of prime beach season. One week is subtracted for inclement weather leaving 10 weeks of prime beach season.

4. Beach Size and Capacity

Table A-2 shows the information on the square feet of dry beach for Revere Beach from 1946-1980. Based upon this information, capacity was estimated using 75 square feet per person and a turnover of two; resulting in a daily capacity of 35,700. The main report presents a detailed analysis of the beach. The beach size is assumed to be constant over the 50 year project life.

*Multiple Responses were received

TABLE A-2

BEACH SIZE

	AREA
1946	915,000 sq.ft.
1962	1,310,000 sq.ft.
1980	1,340,000 sq.ft.

5. Recreation Day Value

The recreation day value for Revere Beach was based upon Table K-31 and K-32 of ER 1105-2-300. The recreational day value for two nearby beaches in Lynn and Beverly was estimated in 1980 reports by NED, to be $1.50 and $1.90, respectively. Since Revere Beach has superior facilities, easier access, and less crowding than these beaches this information on neighboring beaches supports the use of the recreational day value of $2.00 per person, derived from the tables in ER 1105-2-300.

6. Beach Attendance

Revere Beach reached its greatest popularity between 1890 and 1930 when there was a large amusement park behind the beach, a circus, bandstands, dance halls, large hotels, summer homes, and steamship and rail service from Boston making Revere one of the largest and most popular beaches in New England. During this period attendance would frequently reach 80-100,000 on a weekend day. The situation began to change in the 1920's due to major fires at Revere Beach, changing recreational habits, the growing highway system, the increase in automobile ownership, and competition from other beaches. The situation appears to have stabilized with the area behind Revere Beach undergoing redevelopment as discussed in Appendix C.

The reports by Camp, Dresser and McKee and Carol R. Johnson Associates provide an attendance figure for an average peak day and for maximum attendance on a peak day. In order to arrive at an optimistic estimate of current peak attendance the mean of the two figures was computed, although maximum attendance on a peak day would be a rare occurrence reserved for days such as July 4th. The estimates by Camp, Dresser and McKee of 16,000 current daily peak attendance and 24,000 daily peak attendance in 1995 were chosen as being the more reliable and well documented estimates. Both of these estimates include the turnover factor of 2.0.

The consultant's estimates of peak attendance in 1995 are based upon the following assumptions:

1) construction of the Revere Beach Connector

2) renovation of the Wonderland Station and construction of the parking garage

3) construction of the MDC Revere Beach Park

4) construction of the proposed residential units by the ALBA Corporation.

The future of these proposals is not certain and the consultant's estimates based upon these assumptions should be considered an optimistic high growth scenario.

Current beach size results in a capacity far in excess of current attendance and current available parking is also in excess of demand and will remain in excess of projected demand. When considering future beach attendance neither of these two factors serves as a constraint upon growth.

TABLE A-3

DAILY BEACH ATTENDANCE ESTIMATES

	Current Attendance	Future Attendance (1995)
Weekday (1971 Nash-Vigier)	6,800	N/A
Weekday (1978 Camp, Dresser)	N/A	N/A
Weekday (1979 Carol R. Johnson)	5,800	9,700
Peak (1971 Nash-Vigier)	15,700	N/A
Peak (1978 Camp, Dresser)	12,000/20,000	20,000/27,000
Peak (1979 Carol R. Johnson)	14,000/22,000	20,000/30,000

7. Future Beach Attendance

The future peak day attendance is shown in Table A-4 and in Figure A-1 for several growth rates. Future weekday attendance figures are not shown since the current beach capacity is almost six times current attendance and there are no estimates of future excess demand for weekdays. The annual compound growth rate for the population of Revere is 1/4 percent and this rate is applied to beach attendance. The consultants' estimate for attendance in 1995 results in an annual compound growth rate of 2-3/4 percent. Annual growth rates of 1 percent and 5 percent were also computed to provide a sensitivity analysis.

GROWTH IN DAILY PEAK DAY ATTENDANCE

(ANNUAL COMPOUND GROWTH RATES)

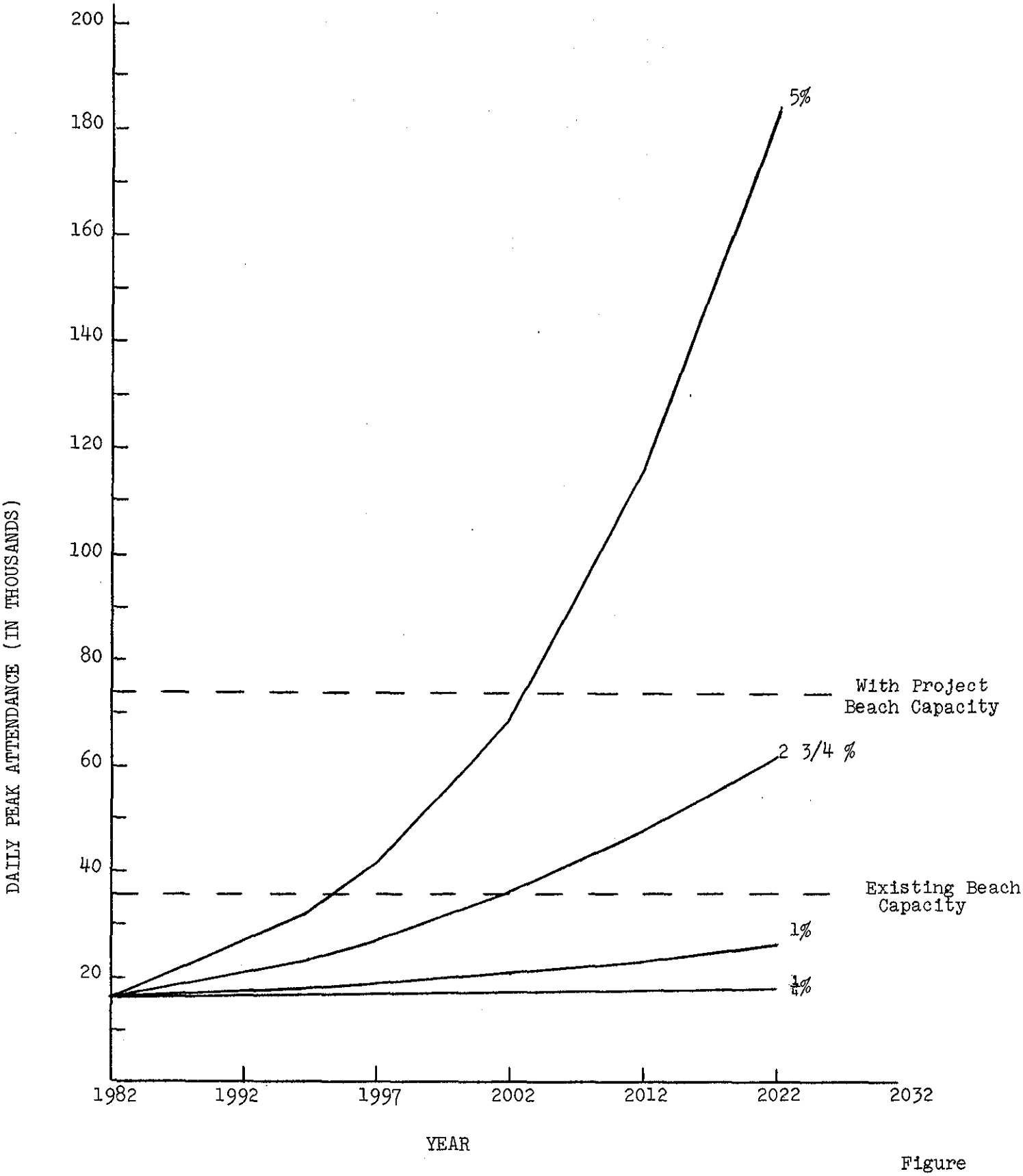


Figure A-1

TABLE A-4

GROWTH IN PEAK DAY ATTENDANCE

Annual Compound Growth Rate	Existing 1982 (Po)	1997 (P15)	2002 (P20)	2012 (P30)	2022 (P40)	2032 (P50)
1/4	16,000	16,700	16,800	17,300	17,600	18,100
1	16,000	18,600	19,500	21,600	23,700	26,200
2-3/4	16,000	24,000	27,200	36,800	48,000	62,400
5	16,000	33,300	42,400	69,100	112,000	184,000

Under the without project condition for the growth rate of 2-3/4 percent attendance would increase until 2012 when the existing beach would be filled to its capacity. The with project condition would be the construction of a beach with 2,763,000 square feet increasing the capacity to 73,700 allowing the beach attendance to grow unrestrained for the life of the project.

As mentioned earlier the 2-3/4 growth rate used by the consultants is the rate selected for evaluating the project. This growth rate is optimistic in the short run since it is based upon scenario of considerable development behind Revere Beach. To continue this growth rate for the entire project life is even more optimistic.

The five percent growth rate is shown although it is far higher than any reasonable projection of beach attendance. It results in attendance doubling every 15 years and the attendance after 50 years would be 12 times the current attendance.

8. Recreational Benefits

The annual recreational benefits are based upon future peak attendance using the Federal interest rate of 7-3/8 percent for the 50 year project life assuming 20 peak days per season and a unit day value of $2.00 per person. The annual recreation benefit was estimated for the difference of the annual recreation values under the with project condition and the without project condition. Table A-5 shows the annual recreation benefit for selected beach attendance growth rates. These annual recreation benefits were estimated to illustrate the sensitivity of annual recreation benefits to various beach attendance growth rates.

TABLE A-5

RECREATION BENEFITS
(1981 Price Level)

Annual Compound Growth Rate	Annual Benefits
1/4 percent	$ 0
1 percent	$ 0
2-3/4 percent (actual growth rate)	$ 39,000
5 percent	$243,000

Table A-6 shows the computations of annual recreation benefits for the beach attendance growth rate of 2-3/4 percent annually. As discussed previously the 2-3/4 percent growth rate was chosen as the most optimistic scenario possible for the growth in beach attendance. Currently there is excess capacity and based upon the existing daily demand of 16,000, the 2-3/4 percent growth rate, and stable beach capacity there would not be excess demand under the without project condition until approximately 2012. Annual benefits to the Federal project do not occur until the 30th year of the project.

TABLE A-6

COMPUTATION OF ANNUAL PEAK DAY RECREATIONAL BENEFITS

REVERE BEACH

YEAR	(P0) 1982	(P15) 1997	(P20) 2002	(P30) 2012	(P40) 2022	(P50) 2032
Value per Beach Unit	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00
Number of Peak Days	20	20	20	20	20	20
Project Annual Peak Day Beach Attendance With the Project 2-3/4% Annual Growth Rate	16,000	24,000	27,200	36,800	48,000	62,400
Project Annual Peak Day Beach Attendance Without the Project 2-3/4% Annual Growth Rate	16,000	24,000	27,200	35,700	35,700	35,700
Projected Annual Recreation Value With the Project	%640,000	$960,000	$1,088,000	$1,427,000	$1,920,000	$2,496,000
Projected Annual Recreation Value Without the Projected	$640,000	$960,000	$1,088,000	$1,428,000	$1,428,000	$1,428,000
Annual Recreation Benefits	Ø	Ø	Ø	$ 44,000	$ 492,000	$1,068,000

Equivalent Average Annual Recreational Benefits $39,000
(50 Year Project Life, 7-3/8%)

9. Annual Flood Losses and Benefits

Flood losses for the area behind Revere Beach are derived from a preliminary damage survey completed in May, 1979 for a reconnaissance report accomplished under the Army Corps of Engineers Section 205 Authority.

The degree of protection offered by the existing seawall and beach is approximately up to the 100 year event. Only annual losses prevented for events greater than the 100 year frequency event could be attributed to the proposed Federal project. The potentially preventable annual losses are $50,000, however, since the 1979 damage survey there have been several changes in the projected area which must be considered. Drainage improvements have been added since the 1979 study; the MDC Revere Beach Reservation has been constructed; and some of the amusements and retail establishments in the area have been removed. In addition, an extensive damage survey completed in the fall of 1980 for Roughan's Point section of Revere indicates a 50 percent reduction in annual losses for Roughan's Point from the June 1979 study. Since the 1980 study was a more intensive study the 1980 results are considered more reliable, a 50 percent reduction in annual losses for the area behind Revere Beach is assumed to reasonable. The addition of the proposed Federal project would give protection against greater than a 500 year event. The annual benefits for the reduction of flood losses for the proposed Federal project of $25,000 are attributable to prevention of annual flood losses for an event greater than the 100 year event and less than the 500 year event.

10. Justification

Based upon the economic analysis the proposed Federal project is not economically justified.

	Annual Benefits	Annual Costs	Benefit to Cost Ratio
Recreation	$39,000		
Flood Control	$25,000		
TOTAL	$64,000	$701,000	.10

APPENDIX B

GEOTECHNICAL

APPENDIX B. GEOTECHNICAL

TABLE OF CONTENTS

1. Topographic Features. Revere Beach is located within the Seaboard Lowland Section of the New England physiographic province. The area is characterized by relatively flat and gently sloping terrain with some hilly sections. Elevations range from tide level at the shorelines to over 175 feet NGVD (National Geodetic Vertical Datum) further inland.

2. Geologic Features

a. Overburden. In the regions of higher elevation, the overburden consists primarily of glacially derived material. Till, an unsorted mixture of clay, sand, gravel, and boulders, is common, as are deposits of stratified sand and gravel. Low-lying areas are dominated by recent marsh sediments, primarily peat and organic silt. Coastal areas are covered by sand with some gravel. Artificial fill is present in various locations.

b. Bedrock. The principal bedrock type in the area is the Cambridge Slate, also known as the Cambridge Argillite. Igneous intrusions and volcanics are also found in the region.

3. Site Conditions. Revere Beach is relatively flat and gently sloping. Slopes range from 1:8 to 1:25 above mean low water and between 1:60 and 1:100 below mean low water. The present beach material is a fine to a medium to fine sand with patches of gravel and silt. Median diameter (D_{50}) of the material ranges from 0.09 to 0.20 mm and averages approximately 0.15 mm. Maximum diameters (D_{100}) are quite variable, ranging from 0.50 mm to over 7.0 mm. Figure B-1 shows gradation characteristics of the existing beach material.

4. Recommended Criteria. The project calls for the widening of 13,000 feet of beach and periodic renourishing. Approximately 1,000,000 cubic yards of sand will be required. The median diameters of the sand fill should be between 0.3 and 0.7 mm and the maximum size particle should be 2.0 mm in diameter. Five percent of the sandfill may have particle sizes greater than 2.0 mm in diameter.

5. Sand Source Investigations

a. Land Sources. A total of eight potential commercial land sources were investigated in detail. Investigations included site inspections, discussions with representatives of the operators, sampling of the major working faces and stockpiles, mechanical analysis of samples for grain size distribution characteristics, and photographs of the sites. The land sources are located in eastern Massachusetts and southern New Hampshire at haul distances to the project site ranging between 30 and 110 miles.

b. Off-shore Sources. Five potential off-shore sources were identified in a survey of pertinent literature. The most promising of these sites, the Cat Island area, was investigated with seismic reflection and side scan sonar surveys followed by eleven continuous vibratory core borings. Mechanical analysis on core samples were performed to determine

grain size distribution characteristics. The Cat Island Site is located offshore of Salem, Massachusetts approximately ten nautical miles northeast from the project area.

6. Results (Land-Based Sources). The results of the investigations of each potential source are presented below. Gradation curve summaries are shown in Figures B-2 and B-3. Figures B-4 through B-11 show grain size distribution characteristics for each site.

a. Source No. 1

(1) Location - Ossipee, NH

(2) Estimated Quantity Available - Over 1,000,000 cubic yards

(3) Haul - Approximately 110 miles. Source has siding and has previously transported materials to the Boston area by rail.

(4) Description

(a) Four samples of bank-run sand were tested. The samples were light brown, coarse to fine and medium to fine sands with D_{50} sizes ranging from 0.4 mm to 0.7 mm. D_{100} sizes ranged from 3.0 mm to 40.0 mm.

(b) Three samples of processed grits were tested. These were light brown, coarse to fine sands with D_{50} sizes averaging 1.1 mm and D_{100} sizes ranging between 4.0 mm and 10.0 mm.

(c) Two samples of concrete sand were tested. These had D_{50} sizes approximating 0.8 mm and D_{100} sizes of about 9.0 mm.

b. Source No. 2

(1) Location - Hooksett, NH

(2) Estimated Quantity Available - Over 1,000,000 cubic yards

(3) Haul - Approximately 50 miles. Railroad facilities are available near source.

(4) Description - Five samples of bank-run sand were tested. The samples were light brown and yellow brown, coarse to fine and medium to fine sand with D_{50} sizes ranging from 0.2 mm to 0.6 mm. D_{100} sizes ranged from 2.0 mm to 50.0 mm.

c. Source No. 3

(1) Location - Boxborough, MA

(2) Estimated Quantity Available - Over 1,000,000 cubic yards

(3) Haul - Approximately 40 miles by road.

(4) Description - Seven samples of bank-run sand were tested. The samples were light to medium brown, coarse to fine, medium to fine, and gravelly coarse to fine sand with D_{50} sizes ranging from 0.1 mm to 1.5 mm. D_{100} sizes ranged between 0.5 mm and 50.0 mm.

d. Source No. 4

(1) Location - Haverhill, MA

(2) Estimated Quantity Available - 100,000 cubic yards

(3) Haul - Approximately 35 miles by road.

(4) Description - Six samples of bank-run sand were tested. The samples were light to medium brown, coarse to fine and medium to fine sand with D_{50} sizes ranging from 0.3 mm to 0.6 mm. D_{100} sizes ranged between 2.0 mm and 40.0 mm.

e. Source No. 5

(1) Location - Groveland, MA

(2) Estimated Quantity Available - Over 1,000,000 cubic yards

(3) Haul - Approximately 30 miles by road.

(4) Description - Seven samples of bank-run sand were tested. The samples were light brown to yellow brown, coarse to fine, medium to fine, and gravelly coarse to fine sand with D_{50} sizes ranging from 0.3 mm to 0.9 mm. D_{100} sizes ranged between 3.0 mm and 25.0 mm.

f. Source No. 6

(1) Location - Madbury and Dover, NH

(2) Estimated Quantity Available - 500,000 cubic yards

(3) Haul - Approximately 60 miles by road.

(4) Description - This source consists of a working pit and processing plant in Madbury and an undeveloped pit in Dover. Six samples of bank-run sand and one sample of material screened on a 5/16 inch screen were tested. The samples were medium brown, coarse to fine, medium to fine, and gravelly coarse to fine sand with D_{50} sizes ranging from 0.2 mm to 1.2 mm. D_{100} sizes ranged between 3.0 mm and 50.0 mm.

g. Source No. 7

(1) Location - Westford, MA

(2) Estimated Quantity Available - 20,000 cubic yards

(3) Haul - Approximately 30 miles by road.

(4) Description - Two samples of bank-run sand and one sample of processed concrete sand were tested. The samples were coarse to fine sand with D_{50} sizes ranging from 0.7 mm to 1.5 mm. D_{100} sizes ranged from 5.0 to 40.0 mm.

h. Source No. 8

(1) Location - North Plymouth, MA

(2) Estimated Quantity Available - Over 1,000,000 cubic yards

(3) Haul - Approximately 40 miles by road.

(4) Description - One sample of bank-run sand and three samples of processed concrete sand were tested. The samples were light brown, coarse to fine, medium to fine, and gravelly coarse to fine sand with D_{50} sizes ranging from 0.5 mm to 0.7 mm. D_{100} sizes varied between 5.0 mm and 25.0 mm.

7. Results (Offshore Sources). The Cat Island site lies under an average of 25 feet of water. The bottom sediments are characterized by approximately 25 feet of sandy gravel, gravelly sand, and medium to fine sand overlying silt and clay. Lenses of gravel and silt are encountered within the sandy material. Figure B-12 shows gradation curve summaries of potentially suitable material. Figures B-13 to B-23 show the gradation characteristics of the boring samples. Plate B-1 shows the geologic profile through the Cat Island Site.

8. Conclusions and Recommendations

a. Land Sources. All eight of the land sources can meet the established grain size criteria with some dry screening. Five of these sources can provide the total anticipated quantity of material.

b. Offshore Sources. Because of the presence of significant amounts of gravel and silt and the general lack of uniformity of the sediments, it is not recommended that the Cat Island Site or any other offshore site be considered as a potential source of beach fill without considerable processing.

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	- NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	- NO4	SHEAR	CONSOL.	PERM.
RB		1	surface		9	91	0	0.15													
RB		2	surface		1	97	2	0.12													
RB		3	surface		0	98	2	0.12													
RB		4	surface		0	98	2	0.14													
RB		5	surface		0	90	10	0.09													

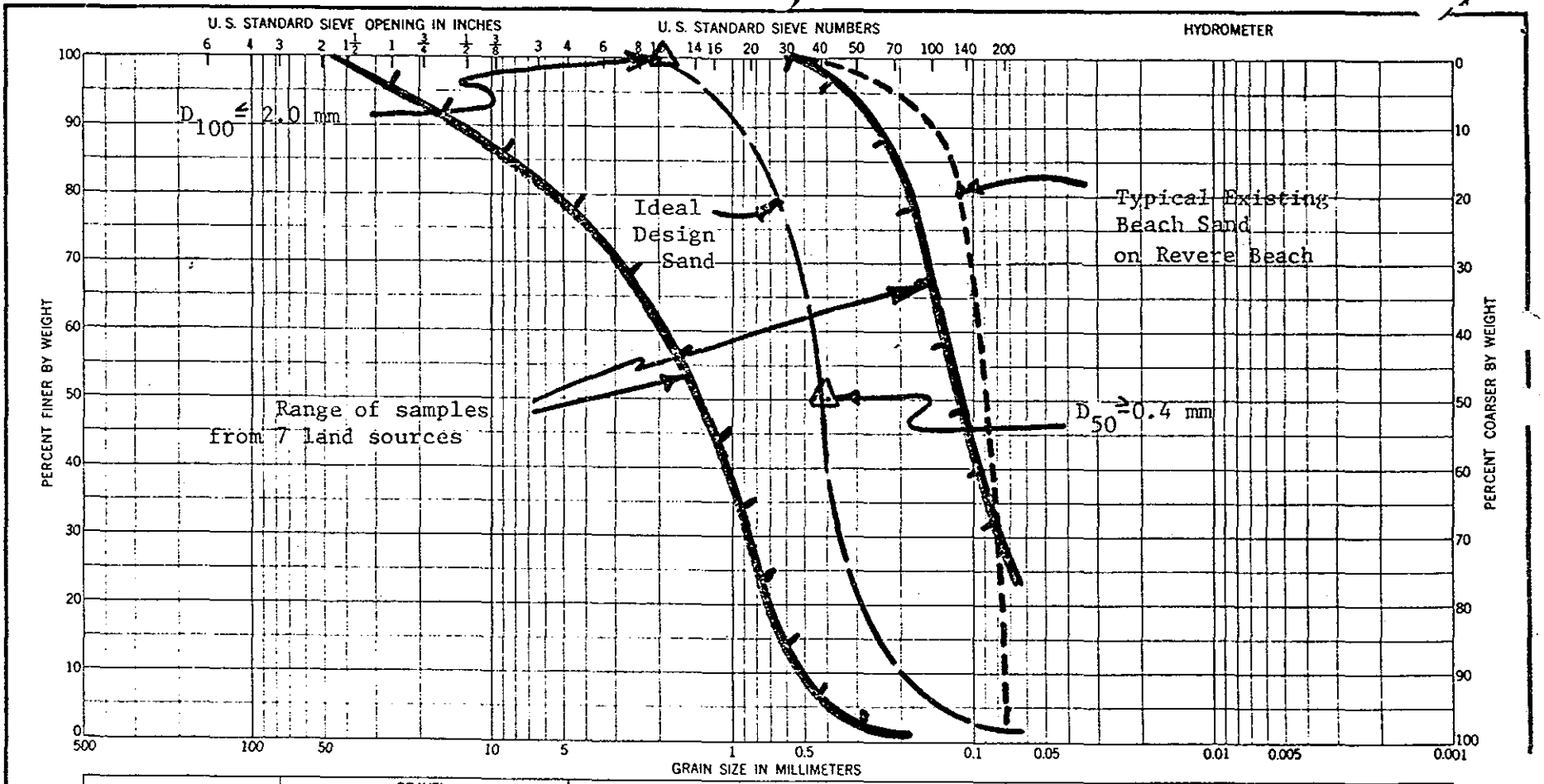
REVERE BEACH RESTORATION PROJECT
REVERE, MA

SUMMARY OF EXISTING BEACH SAND

Fig. B-1

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI

GRADATION CURVES

Project Revere Beach Restoration Project
Revere, MA

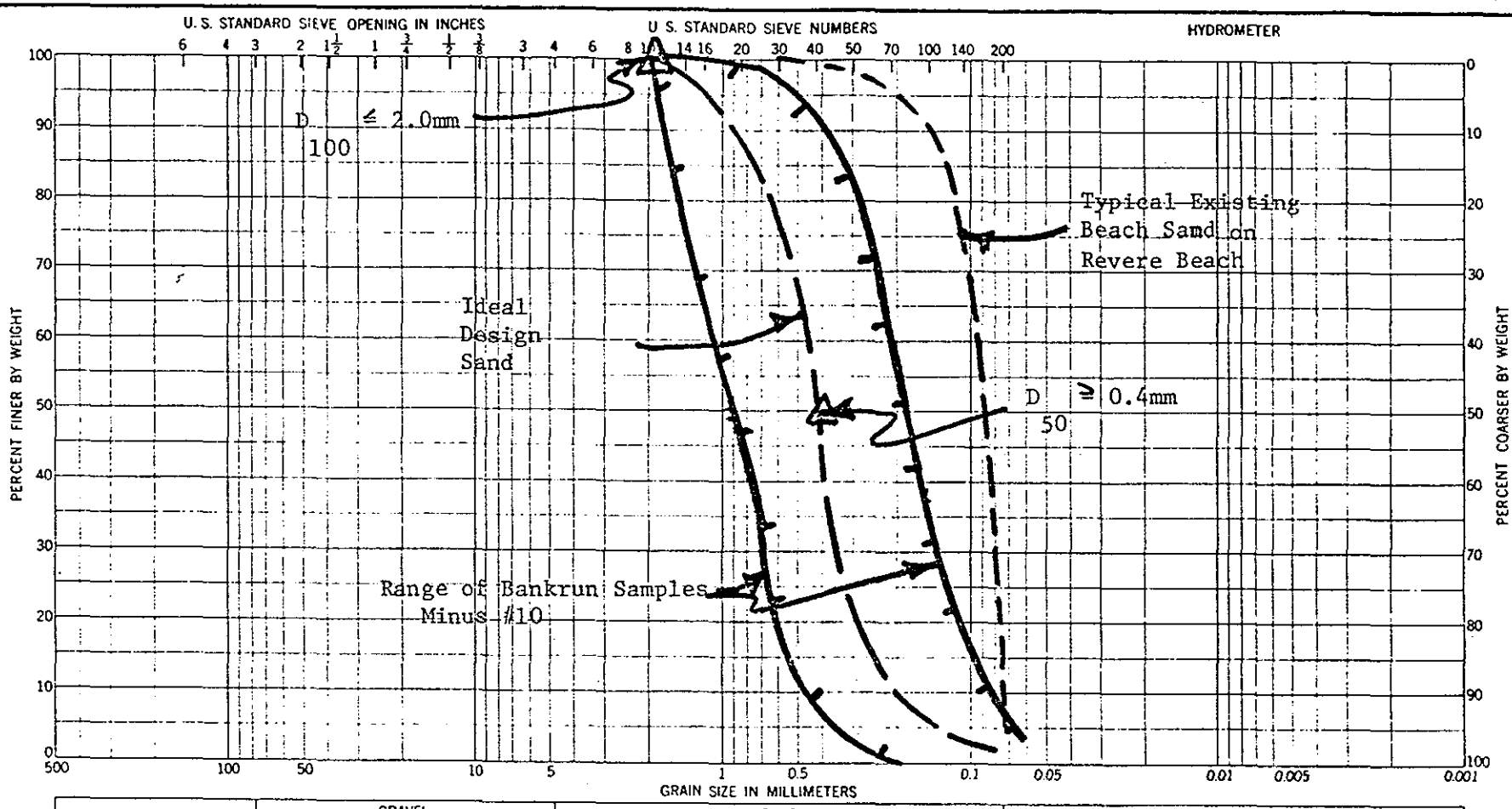
Area Summary of Bank Run Sands

Boring No. from Land Sources.

Date July 1980

ENG FORM 1 MAY 63 2087

FIG. B-2



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI

GRADATION CURVES

Project REVERE BEACH RESTORATION PROJ
REVERE, MA

~~xxxx~~ SUMMARY - BANK RUN MATERIAL

~~XXXXX~~ Boring No. MINUS #10

Date 3 July 1980

ENG FORM 1 MAY 63 2087

FIG. B-3

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.	
1		29	bank run	SP	25	75	0	0.75														
1		30	bank run	SP	0	96	4	0.40														
1		31	concrete pile	SP	7	93	0	0.80														
1		29	screened on #10		0	98	2	0.55														
1		30	screened on #10		0	97	3	0.40														

REVERE BEACH RESTORATION PROJECT
REVERE, MA

SUMMARY OF SAMPLES FROM LAND SOURCE #1

FIG. B-4

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	STND. AASHO OPT. WATER % DRY WT	STND. AASHO MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.	
2		21	bank run	SP	5	93	2	0.50														
2		22	bank run	SP	15	83	2	0.55														
2		23	bank run	SP	0	98	2	0.35														
2		24	bank run	SP	4	94	2	0.55														
2		25	bank run	SP	0	96	4	0.20														
2		21	screened on #10		0	98	2	0.45														
2		22	screened on #10		0	99	1	0.50														
2		23	screened on #10		0	97	3	0.35														
2		24	screened on #10		0	98	2	0.50														
2		25	screened on #10		0	93	7	0.20														

REVERE BEACH RESTORATION PROJECT
REVERE, MA

SUMMARY OF SAMPLES FROM LAND SOURCE #2

FIG. B-5

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.
3		1	bank run	SP	0	99	1	0.35													
3		2	bank run	SP	8	91	1	0.45													
3		3	bank run	SP	25	71	4	1.20													
3		4	bank run	SP	25	75	0	1.50													
3		5	bank run	SP	11	85	4	0.50													
3		1	screened on #10		0	99	1	0.35													
3		2	screened on #10		0	99	1	0.40													
3		5	screened on #10		0	96	4	0.40													

REVERE BEACH RESTORATION PROJECT
REVERE, MA

SUMMARY OF SAMPLES FROM LAND SOURCE #3

FIG. B-6

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	STND. AASHO OPT. WATER % DRY WT	STND. AASHO MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.	
4		16	bank run	SP	11	86	3	0.40														
4		17	bank run	SP	5	92	3	0.45														
4		18	bank run	SP	15	83	2	0.60														
4		19	bank run	SP	11	85	4	0.45														
4		20	bank run	SP	8	89	3	0.40														
4		16	screened on #10		0	97	3	0.30														
4		17	screened on #10		0	94	6	0.40														
4		18	screened on #10		0	97	3	0.40														
4		19	screened on #10		0	94	6	0.35														
4		20	screened on #10		0	97	3	0.35														

REVERE BEACH RESTORATION PROJECT
REVERE, MA

SUMMARY OF SAMPLES FROM LAND SOURCE#4

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

FIG. B-7

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.	
5		11	bank run	SP	0	99	1	0.35														
5		12	bank run	SP	4	95	1	0.45														
5		13	bank run	SP	7	92	1	0.65														
5		14	bank run	SP	2	97	1	0.60														
5		15	bank run	SP	5	94	1	0.60														
5		11	screened on #10		0	99	1	0.35														
5		12	screened on #10		0	99	1	0.40														
5		13	screened on #10		0	99	1	0.60														
5		14	screened on #10		0	99	1	0.60														
5		15	screened on #10		0	99	1	0.55														

REVERE BEACH RESTORATION PROJECT
REVERE, MA

SUMMARY OF SAMPLES FROM LAND SOURCE#5

FIG. B-8

NED FORM JUL 63 510

* PROVIDENCY VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.
6		32	bank run	SP	7	92	1	0.40													
6		34	bank run	SP	12	87	1	1.00													
6		35	bank run	SP	12	87	1	0.80													
6		36	bank run	SP	11	88	1	0.60													
6		32	screened on #10		0	97	3	0.35													
6		34	screened on #10		0	99	1	0.90													
6		35	screened on #10		0	99	1	0.70													
6		36	screened on #10		0	99	1	0.50													

REVERE BEACH RESTORATION PROJECT
REVERE, MA
SUMMARY OF SAMPLES FROM LAND SOURCE#6

FIG. B-9

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.
7		8	concrete pile	SP	10	90	0	1.50													
7		9	bank run	SP	30	70	0	1.00													
7		10	bank run	SP	8	91	1	0.70													
7		9	screened on #10		0	98	2	0.70													
7		10	screened on #10		0	98	2	0.65													

REVERE BEACH RESTORATION PROJECT
REVERE, MA

SUMMARY OF SAMPLES FROM LAND SOURCE#7

FIG. B-10

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.
8		1	concrete pile	SP	2	98	0	0.55													
8		2	concrete pile	SP	1	99	0	0.65													
8		3	unprocessed concrete pile	SP	1	99	0	0.50													
8		4	bank run	SP	4	93	3	0.55													

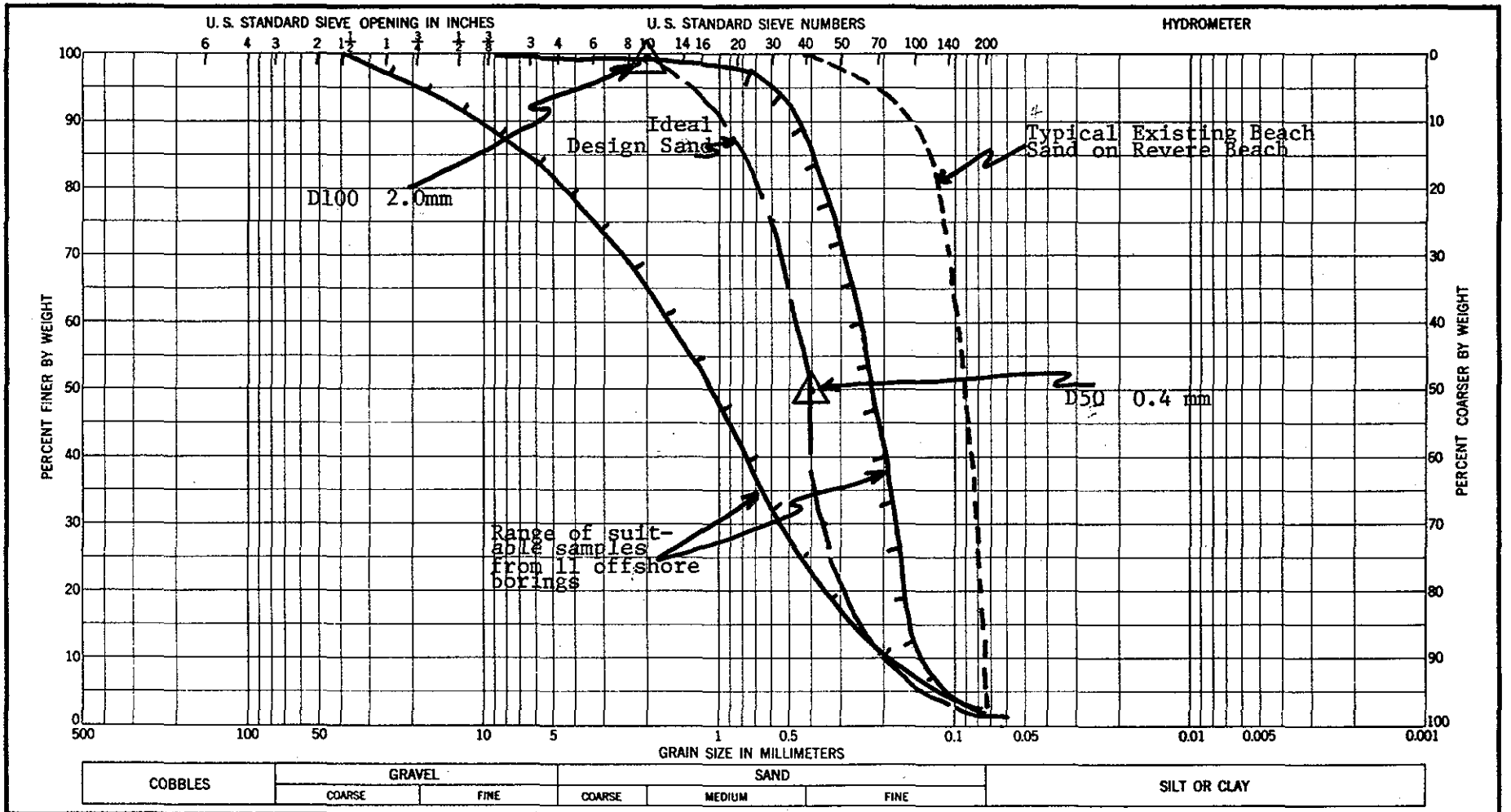
REVERE BEACH RESTORATION PROJECT
REVERE, MA

SUMMARY OF SAMPLES FROM LAND SOURCE#8

FIG. B-11

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI

GRADATION CURVES

Project: Revere Beach Restoration Project
Revere, MA

Area: Summary of Potentially Suitable Material from Offshore Sources

Boring No.

Date: November 1980

FIG. B-12

ENG FORM 1 MAY 63 2087

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	STND. AASHO OPT. WATER % DRY WT	STND. AASHO MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.
BD-1	-26.8	A	0 - 2.0	SP	14	84	2	0.35													
BD-1		A	2.0-6.0	SP	12	87	1	0.38													
BD-1		B	6.0-13.0	SP	0	98	2	0.21													

REVERE BEACH RESTORATION PROJECT
REVERE, MA

SUMMARY OF SAMPLES FROM CAT ISLAND
CORE BD-1

FIG. B-13

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	STND. AASHO OPT. WATER % DRY WT	STND. AASHO MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.
BD-2	-24.8	A	0 - 5.4	SP	26	73	1	0.60													
BD-2		B	5.4 - 7.0	SP	25	74	1	0.62													
BD-2		B	7.0 - 9.9	SP	28	71	1	0.70													
BD-2		C	9.9 - 15.5	SP	14	85	1	0.30													
BD-2		D	15.5 - 16.5	SP	3	95	2	0.18													

REVERE BEACH RESTORATION PROJECT
REVERE, MA

SUMMARY OF SAMPLES FROM CAT ISLAND
CORE BD-2

FIG. B-14

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.	
BD-3	-22.6	A	0 - 5.0	SP	5	94	1	0.22														
BD-3		B	5.6 - 11.4	SP	0	98	2	0.21														
BD-3		C	12.0 - 17.2	SP	7	92	1	0.23														
BD-3		D	17.2 - 20.9	SP	0	97	3	0.26														
BD-3		E	20.9 - 28.0	SP	0	96	4	0.21														
BD-3		F	28.0 - 28.5	MH	1	19	80	*														
BD-3		F	28.5 - 34.4	MH	0	4	96	*														
BD-3		G	34.4 - 36.0	MH	0	3	97	*														
BD-3		G	36.0 - 39.0	CH	0	2	98	*														

* NOTE: no Hydrometer analyses performed on fines.

REVERE BEACH RESTORATION PROJECT
REVERE, MA

SUMMARY OF SAMPLES FROM CAT ISLAND
CORE BD-3

FIG. B-15

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.
BD-4	-23.6	A	0 - 3.6	GW	68	32	0	25.00													
BD-4		B	3.6 - 4.5	SP	37	62	1	1.40													
BD-4		B	4.5 - 6.0	SP	4	92	4	0.28													
BD-4		C	6.0 - 10.0	SP	1	97	2	0.23													
BD-4		D	10.0 - 15.0	SP	0	98	2	0.25													
BD-4		E	15.0 - 19.0	SP	1	97	2	0.23													
BD-4		F	19.0 - 24.5	SP	10	89	1	0.28													

REVERE BEACH RESTORATION PROJECT
REVERE , MA
SUMMARY OF SAMPLES FROM CAT ISLAND

CORE BD-4

FIG. B-16

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	STND. AASHO OPT. WATER % DRY WT	STND. AASHO MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.
BD-5	-24.6	A	0-5.0	GP	52	47	1	5.00													
BD-5		B	5.0-10.0	SP	2	96	2	0.26													
BD-5		C	10.0-15.0	SP	6	92	2	0.26													
BD-5		D	16.0-21.0	SP	4	95	1	0.27													
BD-5		E	21.0-26.0	SP	9	88	3	0.29													
BD-5		F	27.0-33.0	ML	0	41	59	*													
BD-5		G	33.0-40.0	MH	0	11	89	*													

REVERE BEACH RESTORATION PROJECT
REVERE, MA
SUMMARY OF SAMPLES FROM CAT ISLAND

CORE BD-5

* NOTE: no hydrometer analyses performed on fines.

FIG. B-17

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.
BD-6	-26.0	A	0 - 4.5	SP	31	69	0	1.00													
BD-6		A	4.5-6.0	SP	6	92	2	0.24													
BD-6		B	6.0-12.0	SP	8	91	1	0.22													
BD-6		C	12.0-18.0	SP	1	95	4	0.19													
BD-6		D	19.0-25.0	MH	0	8	92	*													
BD-6		E	25.0-27.5	ML	2	36	62	*													
BD-6		E	27.5-28.0	SM	19	44	37	0.29													
BD-6		E	28.0-30.8	CH	0	11	89	*													

REVERE BEACH RESTORATION PROJECT
REVERE, MA
SUMMARY OF SAMPLES FROM CAT ISLAND

CORE BD-6

* NOTE: no hydrometer analyses performed on fines

FIG. B-18

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	- NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	- NO4	SHEAR	CONSOL.	PERM.
BD-7	-26.8	A	0 - 4.0	SP	1	97	2	0.35													
BD-7		B	4.0 - 9.0	SP	7	91	2	0.32													
BD-7		C	9.0 - 13.0	SP	7	91	2	0.28													
BD-7		D	13.0 - 17.0	SP	3	96	1	0.34													
BD-7		E	19.0 - 21.5	SP	8	91	1	0.30													
BD-7		F	21.8 - 24.5	SP	5	94	1	0.26													
BD-7		G	26.8 - 28.1	SM	0	78	22	0.16													
BD-7		G	28.1 - 30.7	MH	0	27	73	*													
BD-7		H	30.7 - 34.6	MH	0	5	95	*													
BD-7		I	34.6 - 38.9	MH	0	17	83	*													

* NOTE: no hydrometer analyses performed on fines

REVERE BEACH RESTORATION PROJECT
REVERE, MA
SUMMARY OF SAMPLES FROM CAT ISLAND

CORE BD-7

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

FIG. B-19

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.
BD-8	-26.6	A	0 - 2.0	SP	28	71	1	0.85													
BD-8		A	2.0 - 5.0	SP	35	64	1	0.58													
BD-8		B	5.0 - 10.0	SP	2	97	1	0.25													
BD-8		C	10.0 - 15.0	SP	6	93	1	0.28													
BD-8		D	16.9 - 21.9	SP	0	97	3	0.25													
BD-8		E	21.9 - 25.9	MH	0	28	72	*													
BD-8		F	25.9 - 29.4	MH	0	17	83	*													
BD-8		F	29.4 - 29.9	CH	0	15	85	*													
BD-8		G	29.9 - 30.9	CH	0	2	98	*													
BD-8		G	30.9 - 35.0	MH	0	3	97	*													

* NOTE: no hydrometer analyses performed on fines

REVERE BEACH RESTORATION PROJECT
REVERE , MA
SUMMARY OF SAMPLES FROM CAT ISLAND

CORE BD-8

FIG. B-20

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.	
BD-9	-27.0	A	0 - 5.0	SP	46	53	1	2.80														
BD-9		B	5.0 - 9.0	SP	17	81	2	0.56														
BD-9		C	9.0 - 16.0	SP	5	93	2	0.35														
BD-9		D	16.5 - 20.0	SP	16	81	3	0.97														
BD-9		E	20.0 - 25.0	SP	7	90	3	1.15														
BD-9		F	25.0 - 27.0	SP	26	73	1	1.80														
BD-9		F	27.0 - 29.0	SM	28	52	20	0.45														
BD-9		G	29.0 - 31.0	SM	29	54	17	0.36														
BD-9		H	31.0 - 38.9	MH	0	5	95	*														

* NOTE: no hydrometer analyses performed on fines

REVERE BEACH RESTORATION PROJECT
REVERE, MA
SUMMARY OF SAMPLES FROM CAT ISLAND

CORE BD-9

FIG. B-21

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	-NO4	STND. AASHO OPT. WATER % DRY WT	STND. AASHO MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.	
BD-10	-30.4	A	0 - 2.5	SP	26	72	2	0.58														
BD-10		A	2.5 - 5.0	SP	0	99	1	0.30														
BD-10		B	5.0 - 10.0	SP	1	97	2	0.28														
BD-10		C	10.0 - 15.0	SP	0	98	2	0.23														
BD-10		D	15.6 - 24.5	SP	8	90	2	0.72														
BD-10		E	25.2 - 30.2	SM	18	52	30	0.13														
BD-10		F	30.2 - 34.0	MH	0	22	78	*														
BD-10		G	34.0 - 38.8	MH	0	9	91	*														

* NOTE: no hydrometer analyses performed on fines.

REVERE BEACH RESTORATION PROJECT
REVERE , MA

SUMMARY OF SAMPLES FROM CAT ISLAND
CORE BD-10

FIG. B-22

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{50} mm.	LL	PL		TOTAL	- NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	- NO4	SHEAR	CONSOL.	PERM.
BD-11	-29.3	A	0 - 5.0	SP	20	79	1	1.10													
BD-11		B	5.0 - 10.0	SP	36	63	1	1.00													
BD-11		C	10.0 - 16.0	SP	25	73	2	1.10													
BD-11		D	18.6 - 20.6	SP	31	67	2	1.05													
BD-11		D	20.6 - 22.8	SP	3	94	3	0.42													
BD-11		E	22.8 - 26.8	SP	6	88	6	0.79													
BD-11		F	26.8 - 30.8	SM	13	44	43	0.14													
BD-11		G	30.8 - 32.8	ML-CL	0	31	69	*													
BD-11		G	32.8 - 34.8	MH	0	27	73	*													
BD-11		H	34.8 - 38.8	MH	0	2	98	*													

* NOTE: no hydrometer analyses performed on fines

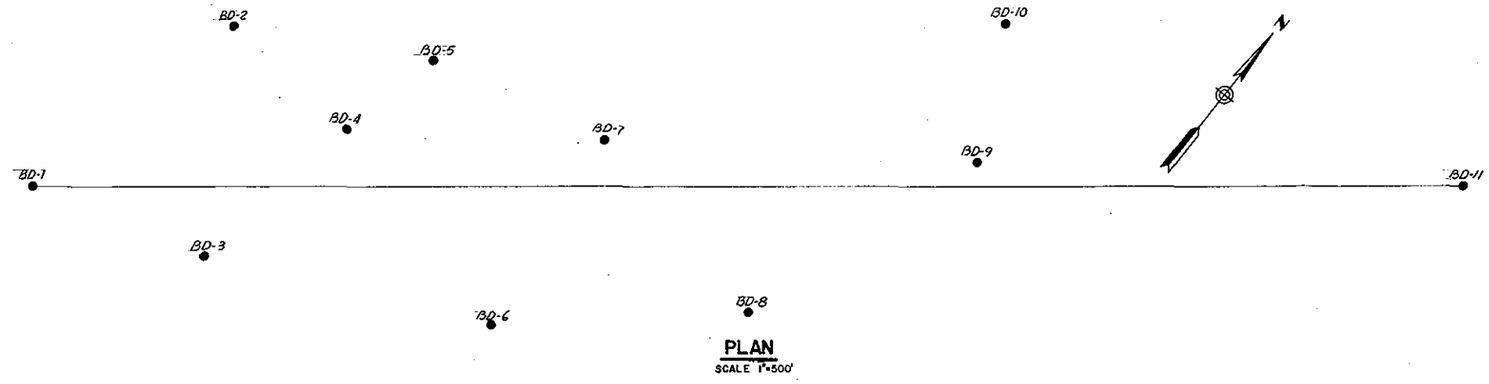
REVERE BEACH RESTORATION PROJECT
REVERE, MA
SUMMARY OF SAMPLES FROM CAT ISLAND
CORE BD-11

FIG. B-23

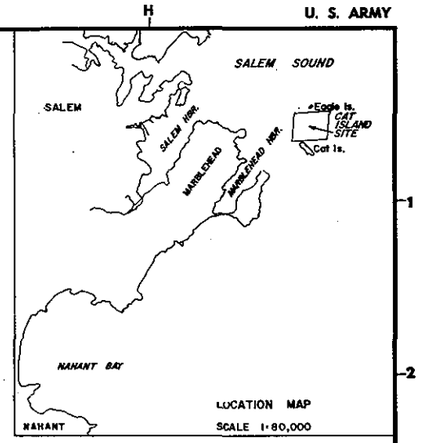
NED FORM 510

* PROVIDENCE VIBRATED DENSITY TEST

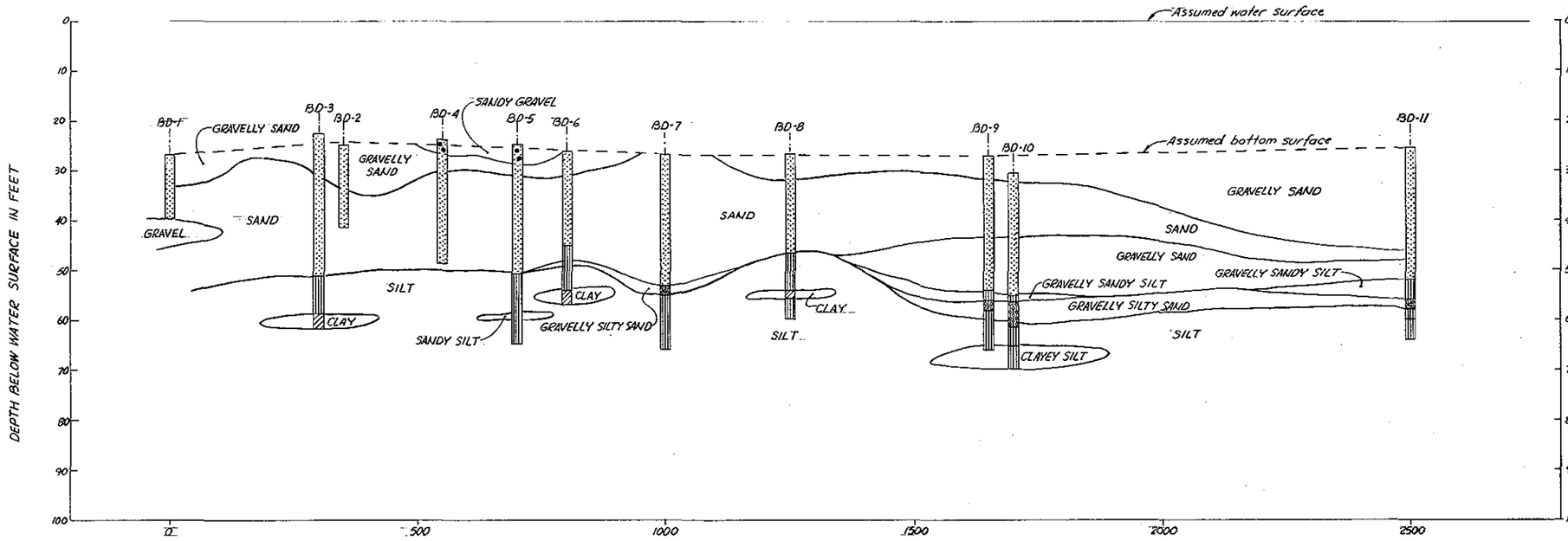
CORPS OF ENGINEERS — U. S. ARMY



PLAN
SCALE 1"=500'



LOCATION MAP
SCALE 1:80,000



LINEAR DISTANCE IN FEET

PROFILE
SCALE HORIZ. 1"=500'
VERT. 1"=10'

NOTE:
Material noted as "SAND" on profile is potentially suitable for beach fill material.

VIBRACORE LOCATIONS
MASS STATE GRID

CORE NO.	EAST	NORTH
BD-1	783,401	553,501
BD-2	783,462	553,970
BD-3	783,735	553,630
BD-4	783,752	553,958
BD-5	783,757	554,150
BD-6	784,174	553,898
BD-7	784,092	554,270
BD-8	784,473	554,226
BD-9	784,590	554,704
BD-10	784,461	554,907

LEGEND

SYMBOL	USCS CLASSIFICATION	DESCRIPTION
	GP	Sandy GRAVEL
	SP	Gravelly SAND & poorly graded SAND
	SM	Silty SAND
	MH	SILT
	ML	Clayey SILT
	CH	CLAY

GRAPHIC SCALES
1:80,000 — 8,000 0 8,000 16,000
1"=10' — 10' 0 10' 20'
1"=500' — 500' 0 500' 1000'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY E.B. | DR. BY J.D. | CK. BY J. O'L.
SUBMITTED: CHIEF, SECTION
APPROVAL RECOMMENDED: CHIEF, BRANCH
RECOMMENDED: James J. O'Leary PROJECT MANAGER
APPROVAL RECOMMENDED: CHIEF, BRANCH

CAT ISLAND, MA.

PLAN OF EXPLORATIONS
AND
GEOLOGIC PROFILE

APPROVED: CHIEF, ENGINEERING DIVISION
DATE JUNE 1981

SCALE AS SHOWN | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE B-1

APPENDIX C

SOCIO-ECONOMIC
AFFECTS ASSESSMENT

APPENDIX C. SOCIO-ECONOMIC AFFECTS ASSESSMENT

TABLE OF CONTENTS

1. Purpose

This appendix presents a discussion of preconstruction, construction, and post-construction impacts of the proposed Revere Beach Erosion Control Project upon residents, potential beach users, and the Metropolitan District Commission (MDC) who controls the beach. In this assessment, current and future social and economic conditions will be identified. In formulating project impacts, future conditions without the project will be compared to future conditions with project implementation.

In describing the social conditions, two different sets of impacts have been incorporated into the report. Those that affect the city of Revere and those that affect the project site, Revere Beach.

2. History of Revere

The city of Revere was established as a small oceanside farming community in the 17th century. It remained that way until its beach area began to develop between 1846 and 1875. With the completion of the narrow gauge railroad in 1875, connecting Revere and Lynn to Boston, Revere experienced a rapid population and housing boom and developed into a beach and summer resort area. By 1890 the town had increased its 1871 population by almost 500 percent. By the turn of the century, Revere had established itself as a resort and residential area in the Metropolitan Boston area. From 1915 to the 1950's Revere's population continued to grow, especially after World War II, as more and more of its farm land was converted into residential neighborhoods. Population has declined slightly between 1970 and 1980. Today, with population of 42,500, some antiquated public services and little industrial growth, it is facing problems similar to many older residential communities located in large metropolitan areas. Revere's character is mainly an entertainment and recreational community containing such facilities as Wonderland Dog Track, Suffolk Downs Raceway, and its most attractive natural feature, Revere Beach.

3. History of Revere Beach

Between 1846 and 1875 the Revere Beach area began to grow. When the narrow gauge railroad was built in 1875, it connected Boston directly to the beach area, bringing thousand of tourists and visitors annually to the shore. In 1895 and 1896 three miles of beachfront property in Revere were acquired by the newly formed Metropolitan Parks Commission (later renamed the Metropolitan District Commission) for use as the first public beach in the nation. The beach is currently operated and maintained by this commission. During subsequent years, the beach's facilities expanded to include four pairs of open air pavilions, an open air bandstand, and a large amusement and entertainment area paralleling the beach. It was estimated that during its peak use, which lasted into the 1930's, over

14,000,000[1] people annually would visit the beach and amusement attraction. Both the beach attendance and facilities began to decline after the mid 1930's due to a number of factors. Increased use of the automobile brought greater social mobility and changing social patterns. Other area beaches within easy commuting distance of Boston attracted large numbers of beachgoers who formerly regarded Revere Beach as their primary recreational resource. Secondly, as the beach and amusement center attendance decreased, profits declined and beach area conditions deteriorated, especially the amusement park area. Most of the amusement area was torn down due to its dilapidated appearance by the early 1970's, much of it still remains as vacant land.

This beach is operated and maintained by the MDC. Periodic repairs and construction have taken place along its length over the years. Initially, a seawall was built along the backshore of the beach and completed in 1920. A seawall cap was added in 1963 and 1964. In 1954 as part of the Congressionally authorized erosion project for Revere, the MDC pumped 175,000 cy of sandfill onto the beach from an offshore borrow pit. The project was discontinued because the sand particles were too small to remain on the beach. This has been the only significant beach fill which has taken place since the early part of the century. After the February 1978 storm, some repairs were made to the seawall and pavilions damaged by the storm. Presently, the condition of the beach is regarded as poor. Along the 15,000 feet of beach from Eliot Circle in the south to Northern Circle, erosion has caused uneven beach conditions to exist. In some areas, especially in the south beach area, accretion of beach material has occurred and the beach is actually enlarging. Near Chester Street, localized erosion has caused little or no dry beach space to remain above mean high water.

4. Existing Conditions

a. Land Use

Revere Beach stretches for a distance of approximately 3 miles in a cresent shape from Roughan's Point at the south to the Point of Pines area at the north. The land opposite the beach along Revere Beach Boulevard is developed in a variety of uses. Along Revere Beach Boulevard are private homes, small apartment houses, a nursing home, a large elderly apartment complex, commercial establishments such as restaurants and lounges, a discount store, and a bowling alley. Thirty percent of the land between Beach Street and Revere Street is vacant. The new MDC linear park is also opposite the beach, paralleling Revere Beach Boulevard for approximately one mile. Additional MDC facilities are found within the project site in the vicinity of the mid-beach area. These facilities

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[1]Massachusetts Area Planning Council, 1967

include; a bathhouse, a sanitary facility and the MDC Police Station. The land across from the beach has been rezoned to meet current flood control standards and to allow private development to take place along the former site of the large amusement complex.

b. Beach Attendance

During peak use years, the early 1900's, Revere Beach was a very heavily populated beach due to the many recreational and entertainment facilities it provided. On a peak summer weekend day, as many as 100,000 people (based on newspaper reports) would visit the beach and amusement center. Annual attendance estimates reveal as many as 14,000,000[1] people would visit this area. Since the mid 1930's, attendance at Revere Beach has declined significantly as previously discussed. The amusement center at Revere Beach has been completely torn down and is waiting private development which does not at this time include a large entertainment/ recreational oriented complex. Damage to sections the beach itself has probably contributed to its decreased utilization.

There have been several studies completed for the MDC and the city of Revere regarding present beach attendance figure. In 1971, the firm of Nash-Vigier completed a comprehensive study for Revere. They determined annual beach attendance to be 650,000 who use the beach proper.[2] Carol R. Johnson and Associates completed a study for the MDC in 1979. The findings of this study are illustrated below in Table C-1.

TABLE C-1

DAILY BEACH ATTENDANCE AT REVERE BEACH

	Condition	Daily Attendance
1.	Average summer weekend	14,000
2.	Peak summer weekend	22,000
3.	Average summer weekday	6,800
4.	Average non-summer weekday	negligible

Source: Carol R. Johnson and Associates, Revere Master Plan, 1979.

> "The MDC has based future estimates, in part, upon present and past use comparisons. Present visitor use is 12,000 on an average weekend day to 20,000 on a peak weekend day, and past visitor use estimates of 11,240 on any season day."[3]

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[1]MAPC, 1967
[2]Nash Vigier, Volume 3. April 1971.

Given the present dry beach area at mean high water, there is presently room for approximately 36,000 people. This will comfortably accomodate present beach users as estimated by the three studies above.

c. Local Economy

Revere Beach is operated and maintained by the MDC and has been since 1895. Money to maintain the beach and its facilities is appropriated by the Commonwealth of Massachusetts in its annual State budget. Each city and town under the jurisdiction of the MDC is assessed a certain amount of money for maintenance and operation costs of MDC facilities. The MDC can use this money for their costs and also to help fund additional facility related projects such as the one under current consideration for Revere Beach.

The local economy at the city of Revere is heavily concentrated in the service and trade sectors, with some of these establishments in direct support of the Revere Beach area. Restaurants, some lounges, a discount store, a bowling alley, and some small concessions are opposite the project site, along Revere Beach Boulevard. Other service and trade concerns such as gas stations, small stores, other restaurants and lounges, and private parking facilities are found throughout the immediate beach area and nearby sections of the city.

Revere's economy is strongly dependent upon its entertainment and recreational opportunities. Three of the city's principal attractions can be categorized as entertainment and recreational: Revere Beach, Suffolk Down Race Track, and Wonderland Dog Track. Two-thirds of the city's work force commute outside the city each day for work. Seventy-seven percent of all the people employed within the city of Revere are employed in the service and trade sectors.

5. Future Conditions Without the Project

a. Land Use

The most prevalent land use throughout the project area is the 15,000 feet of beach from Eliot Circle in the south to northern circle. Without the project, the major result will be a continuation of present conditions. There will be accretion of beach material in the southern part of the project area, around Cresent Beach, while erosion will continue to cause decreasing dry beach space in the vicinity of the MDC public facilities across from the beach. Damage to the concrete apron along the base of the seawall and the seawall itself will continue to occur, as there will be little in the way of a beach berm to protect these walls from direct wave action. Damage to the base of some of the open air pavilions will also reoccur as waves may strike these structures directly.

Across from the project area is a variety of land uses which face periodic damage during serious winter storms. If waves overtop the existing seawall, Revere Beach Boulevard could be flooded. The water could then continue across the road and damage sections of the MDC park and some of the public facilities and private establishments on the other side of the boulevard. Future land use plans for the area seem to indicate that if present economic conditions ameliorate, it would then be possible to go ahead with the redevelopment plan for the area, already in the planning stage and involving the MDC, the city of Revere and a private developer. These plans will be delineated further in the Economic Development Section, which follows.

b. Projected Beach Attendance

Based on a number of current estimates, attendance at Revere Beach is not expected to significantly increased in the future. The MDC has stated that future average weekend day visitor use will be 20,000 persons based upon:[1]

- current estimates of beach use
- number of available parking spaces (2500)
- design consideration inherent in the currently estimated capacity of Revere Beach

Future beach use estimates for design year 1995 were made by Carol R. Johnson and Associates as part of the study completed for the MDC in 1978. Their assumptions are based upon the completion of a comprehensive redevelopment project along the beachfront area at Revere Beach. Table C-2 presents their finding for four different beach conditions.

TABLE C-2

FUTURE BEACH ATTENDANCE AT REVERE BEACH

	Condition	Daily Beach Attendance
1.	Average summer weekend	20,000
2.	Peak summer weekend	30,000
3.	Average summer weekday	9,710
4.	Average non-summer weekday	negligible

Source: Carol R. Johnson and Associates, Revere Master Plan, 1978.

[1]Carol R. Johnson and Associates, Revere Master Plan, 1978.

Currently, beach intensity is very uneven along the beach. As was previously stated, those sections of the beach across from the "amenities," have heavier beach use even though there is less dry beach area present. Other more stable areas of the beach, away from the bather amenities, have more dry beach area but fewer users. Those areas suffering from erosion will continue to have decreasing dry beach area which may cause beach users, who frequent these sections, to move either north or south of the affected area or select an alternative beach. This fact could decrease beach attendance in general over the entire beach. It will depend on what the beach user finds more important, adequate beach space or adequate social amenities. In general, the eroded areas will undoubtedly suffer some declining use as dry beach area will continue to decrease.

c. Economic Development

There are several general redevelopment proposals for Revere Beach and the city which both the MDC and Revere offficials hope will generate economic revitalization. These proposals include:

- The Revere Beach Development Project, a concerted effort involving the city of Rever, a State agency, the MDC, and a private developer. It includes the construction of two high-rise apartment and condominium complexes, a linear park along the beach for passive recreation, which is being currently completed by the MDC, a 2000 car parking garage, and a commercial area set between the residential structures. Much of this development is located across from the proposed erosion control project site.

- The Army Corps of Engineers will be implementing additional flood control studies in the Oak Island and Point of Pines sections of Revere to augment ongoing studies involving Roughan's Point.

- The Boston Celtics and the Ogden Corporation are currently negotiating a proposed sports arena within the Suffolk Downs complex. This plan is awaiting financial approval. It will add another major recreational/entertainment asset to the city.

- The Massachusetts Coastal Floodproofing Program will release $317,000 to Revere homeowners currently on the waiting list, so that repairs and/or additional floodproofing measures can be implemented on homes that suffered damage during the serious storm of February 1978.

6. Future Conditions With Project Implementation

a. Land Use

With project construction, erosion and accretion of the beach will most probably stop as the beachfill stabilizes itself. Damage to the concrete apron and seawall will be lessened as fewer waves will reach them because of the new beach berm. The open air pavilions will not be damaged by direct wave attack. Revere Beach Boulevard roadway will be flooded less frequently. Wave overtopping damage to the MDC linear park would be less frequent. Redevelopment would be no different from the without project condition.

b. Beach Attendance[1]

Several different sources were chosen to derive future beach attendance figures for Revere Beach. The MDC, which controls the beach, estimates that on a future average weekend day about 20,000 people could be expected to visit the beach, and as many as 30,000 on a peak weekend day. Carol R. Johnson and Associates estimate that by 1995 approximately 40,000 people will utilize the beach on a peak summer weekend day.[2] The Nash-Vigier study of 1971 estimated future peak attendance at 30,000 persons which could be expanded to between 30,000 and 40,000 depending on suggested beach area improvements and the fact that future economic constraints may force many Metropolitan Boston area residents to seek recreational activities closer to home.

c. Economic Development

Opportunities for economic development with project implementation will be unchanged from those discussed for the without project condition.

d. Social Impacts

Short term related impacts of increased noise, dust, men, and equipment entering and leaving the project site would be experienced during the construction phase. Additional short term negative impacts include:

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[1]Beach attendance estimates assume a daily turnover rate of two.

[2]Carol R. Johnson and Associates, 1978 study, based upon optimum conditions which they felt could exist by 1995 with implementation of Revere Master Plan.

- disruption of beach use during the summer, until the project is completed. (Project can only be constructed during the summer when the threat of serious storms, which could wash away beach material, has diminished.)

- parking along Revere Beach Boulevard will be impacted as trucks must utilize this road while entering and leaving the beach area.

- traffic along Revere Beach Boulevard will also be impacted as this road will be used by construction vehicles.

There are several long term positive impacts associated with this project. The most beneficial effect would be the decrease of erosion and the creation of a uniform beach width. A larger dry beach area increases the potential capacity of the beach. Aesthetically, the beach will assume a better appearance, and in addition, beach material will be more suitable for beach users. Also, the scenic nature of this beach, because of its cresent shape, can once again be enjoyed.

e. Economic Impacts

Economic concerns along the beach such as restaurants, small food concessions, lounges, and private parking facilities may face decreasing revenues during their peak season if beach attendance decreases during the construction phase. Additionally, a disruption to parking along the Revere Beach Boulevard may negatively impact potential customers of these establishments who may wish to park near these businesses but cannot due to area construction. The increase in dry beach area this project provides will increase the beach's potential capacity. The midbeach area, one of the more popular beach areas, will be expanded from its present size and be able to comfortably accommodate more people, thereby making the public amenities across from this beach section even more popular than at present. If beach attendance were to increase because of this project, it could generate economic interest in the restaurants, lounges, concessions, private parking facilities and MBTA access areas along the beach.

7. Adverse Impacts That Cannot Be Avoided

a. Social

Decreasing beach attendance during peak season will be experienced during the construction phase, especially along the more crowded midbeach area. People will be forced to move north or south laterally along the beach and further away from public facilities during construction. Since the project will be constructed during the peak season a more serious impact of decreasing beach attendance will occur than if the project could to be completed during the non-peak season. A serious traffic disruption along Revere Beach Boulevard will occur during the construction phase.

b. Economic

There will be negative economic effects which will be experienced during the construction phase. Many of the beaches economic establishments such as restaurants, lounges, and concessions are directly across Revere Beach Boulevard from the work site. These concerns would be expected to enjoy increasing patronage during peak beach season. Since the construction phase of this project will occur during this time expected decrease in beach attendance may adversely affect the economic well-being of these businesses throughout construction time.

c. City of Revere

In addition to the business establishments along the Revere Beach Boulevard that will be affected by the project, other service establishments such as gas stations, restaurants, and stores surrounding the beach area may also be negatively impacted by decreased beach attendance. This may cause a negative effect upon the general economic climate of the city throughout the construction phase.